Microsoft WinHEC

Toward a Standard User Interface for Power Controls

Bruce Nordman – Lawrence Berkeley National Laboratory

Abstract

This paper provides information about a project to accomplish simplicity and similarity of power controls for all office equipment and electronic devices globally—including PCs and PC operating systems. It provides guidelines for hardware and operating system designers to design new products to be consistent with a global voluntary standard. The standard is still being developed, but its overall scope and some pieces of it are already clear. Widespread use of the standard should aid consumer ease of use as well as contribute to significant energy savings, without particularly imposing costs on manufacturers. LBNL-49665.

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Introduction

Significant energy savings for future office equipment and consumer electronics can be achieved through improving the user interface for controlling "power status"—on, asleep, or off. If users better understand how to use automatic and manual controls for power management, they will be more likely to use them. Interface elements that are easier to understand—and more importantly, *consistent* across all electronic devices—should accomplish much of this. In addition to saving energy, standard power controls will improve ease of use.

This discussion covers background information, the scope of the proposed standard, initial recommendations, and specific implications for PCs and PC operating systems.

Lawrence Berkeley National Laboratory is conducting this project due to our long involvement in research about the energy use of office equipment, including a key role in instigating the ENERGY STAR program for PCs and monitors. The California Energy Commission is the sponsor of the project and has a mandate to fund research that is in the public interest and will save energy.

Background: Why People Avoid Power Management

The need for an improved user interface follows from the combination of two facts. First, the "enabling rate" for power management in office equipment is significantly lower than it should be, particularly for PCs. We have estimated that the rate at which power management is enabled and functioning is only 25% for PCs[1] (but considerably higher for monitors, printers, and copiers[2]). Second, the user interface for controlling power management varies considerably from device to device, resulting in much unnecessary confusion. For example, the term "standby" can mean anything from fully on, to a variety of sleep modes, to a form of off. With a few exceptions, the disparity in controls serves no useful purpose.

In the U.S. in 2000, office equipment power management saved about $2.2 billion of electricity. However, another $1.3 billion of additional savings was available if power management had been universally enabled[3]. Over time, the potential savings will only grow, and are multiplied when global savings are considered.

Power status is one of the few features which is common to nearly all electronic devices that people interact with. However, power status and controlling it is generally *not* related to the intended

[1] Certainly some disabling is due to machines that go to sleep but don't wake up, but newer hardware and software is reducing that problem.

[2] Nordman, B., Meier, A., and M.A. Piette. 2000. "PC and Monitor Night Status: Power Management Enabling and Manual Turn-off ." In Proceedings of the ACEEE Summer Study on Energy Efficiency Buildings. August.

[3] Kawamoto, Kaoru, Jonathan Koomey, Bruce Nordman, Richard E. Brown, Mary Ann Piette, and Alan Meier. 2000. Electricity Used by Office Equipment and Network Equipment in the U.S. *Energy*, the International Journal, vol 27, 2002, p255-269. Available at: http://enduse.lbl.gov/Projects/InfoTech.html

function of electronic devices. This is one reason that the power control user interface (UI) has received less attention from industry than other parts of product design.

We investigated user interfaces of a wide variety of products and found that considerable simplification and clarity can be attained by following a few simple guidelines. We believe that use of these in future products will greatly increase the use of power management.

In general, the user interface standard is intended to be strictly voluntary, so as to not stifle innovation or impede the non-standard interfaces where merited. However, in the PC context, at least some of the standard is appropriate to mandate in industry specifications and requirements such as logo programs.

Scope: Broad and Narrow

While problems with power controls are most obvious in office equipment, it makes sense to extend the interface standard to *all* devices that people commonly interact with that may have multiple power states, most prominently consumer electronics. In addition, the distinction between office equipment and consumer electronics is evaporating. Thus, while we are accustomed to designing individual products, this standard is about designing elements of a wide range of products.

The scope is limited to the user interface—just what the user sees directly, in hardware, software, and the behavior of devices. The standard does *not* address internal mechanisms that accomplish power management (such as ACPI) *except* as they affect the UI. Furthermore, the scope does not include power levels or delay times—these are the domain of policy mechanisms such as ENERGY STAR and standby power. So, the scope of the standard for each device is quite narrow.

The research can be roughly divided into two parts. The “hard interface” includes the symbols, terms, and indicators found on the outside of devices, though these are also often repeated on software control panels. “Device behavior” includes the expected response of a device to of each type of input in each power mode.

The standard address individual UI elements—symbols, terms, indicators, and the like. How they are arranged and combined in hardware and on software control panels is outside of the standard’s scope.

First Principles for Interfaces: Initial Recommendations

In July 2001 we proposed the following five guidelines for the “hard interface”:

- Use only three power states when possible: On, Off, and Sleep.
- Use the word "Power" for terminology about power.
- Drop the ⏼ symbol from use and redefine the ⏻ symbol to mean “power” as for on/off (power) buttons and power indicators.
- Use the “sleep” metaphor for entering, being in, and coming out of low-power states; use the moon symbol — ☾ —for sleep.
- Adopt "green/amber/off" color indications for power state indicators.

Discussion

More details can be found on the project web site — http://eetd.LBL.gov/Controls — on the "Publications" page under "Tentative Recommendations", but following are some key points about the initial recommendations.

To the extent possible, device behavior should be consistent within each basic state (for example, wake events from sleep should be the same in all sleep states).

The recommendation on power symbols would require changing the existing international standards (ISO and IEC[4]) but is most consistent with actual usage on current products. The standards define ⏻ as "on/off pushbutton" and ⏼ as "standby"—although "standby" is not well-defined. Anecdotal evidence is overwhelming that few people differentiate between these symbols or know what they mean. We see no need to change to the "on" – | – and "off" – ○ – symbols, but believe that these are best used together, as on rocker switches.

The idea of a device being asleep is the most common description of low-power modes, and is often used even when other terms are used in the UI. The moon is the symbol most commonly used for sleep.

The indicator recommendation is also the usage most in-line with current products. Red should be reserved for warnings, alarms, or errors. Standard indications of "waking up / booting up" and "going to sleep / turning off" should be created, possibly flashing green and flashing amber respectively. Standard audio indications of power state transitions could provide accessibility to the blind, and conditions in which the indicator light is not readily visible.

While not listed among the five initial recommendations, we also believe that "hibernate" modes should be clearly identified as a form of off, and that consequently a new term is needed for hibernate (and possibly an icon).

Status

Industry feedback has been positive. The first four recommendations seem robust and ready for immediate implementation. The indicator light recommendation needs further consideration and consultation, particularly with respect to accessibility and possible special needs of mobile devices. Some current implementations present hibernate as a form of sleep, so the industry needs to work towards a consensus.

We have yet to make initial recommendations on device behavior. These behavior recommendations cover questions such as: "If a device is asleep and you press the power button, what should happen?" Should it turn off, wake up, or remain asleep? Similarly, if the device is off and you press a sleep button, what should happen?

One possible use for power buttons is to have them toggle between the two most common power states, which might be fixed for a device, or (as with many notebook computers) specified by the user. Thus the button might toggle between on and sleep, or between on and some form of off. Regardless of this variation, the button would always return the device to on when pressed while the system is in sleep or off mode.

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[4] IEC 60417, "Graphical symbols for use on equipment"; ISO 7000, "Graphical symbols for use on equipment – Index and synopsis"; and ISO/IEC 13251, "Collective Standard: Graphical Symbols for use on equipment".

The section “Next Steps” explains the process going forward.

Implications for PC Hardware

Many current PC and monitor models already use the ⏻ symbol for power buttons, and nearly all refer to this as the “power” button and indicator. It is also common for user manuals to refer to low-power modes as “sleep” even though Microsoft Windows and DPMS (Display Power Management Signaling) use terms such as “standby” and “suspend”.

Most PCs with a sleep button already use the ☾ symbol. The standard does not address whether a sleep button should be present, but rather only its name, icon, and behavior. It may make sense to identify a standard function key that could serve as a default sleep button for PCs without a separate sleep button.

If the power indicator recommendation remains as-is, some devices will need to convert from a green-only to a bi-color (green/amber) LED, but the incremental cost for a bi-color LED is only about $0.02. Most monitors and many PCs already use the green/amber indications.

Any sleep indicators that are separate from power indicators may need to have their labeling or behavior revised.

Hardware changes such as changing memory or peripheral cards should not be done on a PC that is hibernating. Because a hibernating PC is physically indistinguishable from one that is off due to "shut down," users may try to make these types of hardware changes because they don’t realize that it may cause problems or that the PC is hibernating. For desktop PCs, adding an interior LED that indicates hibernation might solve this problem, though would have to be balanced against the extra manufacturing and energy costs.

For device behavior, PCs should be checked to ensure that they react the same way to user input in all sleep modes. This is difficult if hibernate is included with sleep, which is one of the reasons we favor it being a form of Off.

User manuals need to be reviewed for their consistency with the standard terminology. We will provide some sample explanations that can be adapted for use in manuals to explain the user interface.

Implications for ACPI

The advent of Advanced Configuration and Power Interface (ACPI) was a huge step forward in the internal support for aggressive PC power management. ACPI also aided a standard user interface through use of the sleep metaphor, provisions for power indicators, separate power and sleep buttons (and lid switch), standard battery interfaces, and moving controls from proprietary software into the operating system. However, several items within ACPI could benefit from slight modification and clarification.

For the System Status Indicator facility, we propose changing the “Waking up” indication to also include resuming from S4 or booting up. We also suggest adding an indication that covers both going to sleep and going to off, to parallel the waking indication. Whether this presents any difficulties to implement is not yet known. This is our only proposed change that clearly affects the internal implementation of ACPI.

S4 is a problem. ACPI includes *System States* (S*x*), which are key to ACPI functioning, and the concept of *Global System States* (G*x*), which "are visible to the user". Within ACPI, S4 is most often presented as a form of sleep (G1), is seemingly visible to the user as identical to Soft Off (G2/S5), and in some cases is listed as a separate global state. How S4 is best classified for internal purposes (S*x*) need not be the way it is presented to the user (G*x*), but the ACPI specification does not clearly separate the two.

The ACPI specification should be changed to specify that for the user, the S4 state is a form of off. Thus, the user will only see:

- G0 (working)
- G1 (sleeping—S1-S3)
- G2 (Including Non-volatile Sleep (S4—Hibernate), Soft-Off (S5), and Mechanical Off.)

ACPI does not use the term "hibernate" but rather "non-volatile sleep".

ACPI should also *recommend* that wake events not vary among implemented sleep states, and provide more guidance on how best to deploy the power and sleep buttons, even if the allowed functionality is not changed.

Implications for Peripheral Devices

Devices without power controls or indicators, such as internal cards or external devices such as mice, are not affected by these recommendations. For most other devices, the power UI is simple and easy to conform to these standards. In the long term, we may see displays with power management capability independent of a particular PC, which will require more sophisticated power management controls. Supporting more complex turn-on or wake events (for example, voice commands and hand gestures) may also present challenges.

Implications for Industry Specifications and Requirements

Industry specifications and requirements (such as for logo programs) should be amended to implement these recommendations, with changes flowing from recommendations to requirements over time as manufacturers are able to readily implement them. While PCs are the main focus of these documents, some of the recommendations would apply to monitors and other peripherals.

Implications for future Operating Systems

For all operating systems, initial changes are only in terms and symbols, though forthcoming recommendations may extend to default settings and operating system power policies. It may be advisable to use the "Power" symbol — ⏻ — for control panel icons. The details below are not exhaustive, but indicative of changes needed for consistency with the voluntary standard.

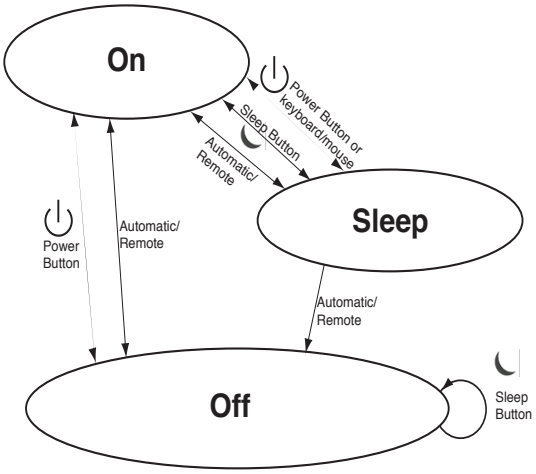
In Microsoft® Windows®, most needed changes are to Power Options in the Control Panel, Start menu, and the Shut Down dialog box. References to Standby should be replaced with Sleep. If multiple low-power modes are referred to (for example, Standby and Suspend), gradations of sleep should be used (for example, "light sleep" and "deep sleep"). The graphic version of the Shutdown ("Turn off computer") dialog box (present in some versions of Windows XP) should have the symbols for Sleep and Turn Off revised to be consistent

with this standard. Also, the color choices and restart icon should be revisited.

For Apple Macintosh operating systems, the Energy Saver control panel should be renamed to include the word “Power”. For Linux (Gnome), power controls should be moved out of the screensaver control panel into a Power control panel, in anticipation of better power management support within Linux. Also, the display settings should use “sleep” rather than “shut down”. For Solaris, the use of “Suspend” for hibernate should be changed.

A new term for the hibernate function is needed, and it should be clearly associated with Off rather than Sleep. One possibility is to use “Off” for S4 and use “Shut down” for S5. The new power symbol — ⏻ — is now available as a synonym for the word “power” anywhere in the user interface.

Next Steps



This process is ongoing, and your attention and comments are critical. This paper summarizes the state of the standard as of February 2002. The effort will only succeed if the principles and design elements identified for the voluntary standard meet the needs of and are acceptable to the broad majority of the office equipment and consumer electronics industries.

Topics that merit additional inquiry will be subjected to field tests or other examination to confirm their merit or identify better alternatives.

As consensus emerges on specific recommendations, they will be presented for consideration and approval to the project’s Professional Advisory Committee. This group is made up of representatives from key companies in the office equipment and consumer electronics industries. Companies, such as Microsoft, will follow their own processes to determine how they will implement the results. We will contact organizations with relevant standards or specifications (for example, IEC/ISO, ACPI, and VESA—Video Electronics Standards Association) for any proposed modifications.

The ultimate repository of the voluntary standard is not yet clear. The institution and form of document should be one that facilitates free availability of the information and timely updating as technologies and experience suggest. Additionally, it should contain considerable discussion of the rationale for the standards and implementation guidelines, in addition to the specific elements of the standard.

Further recommendations are forthcoming on device behavior, and possibly on accessibility, batteries, and other topics (see “Project Scope and Research Topics” on the project web site).

Success = Overlooked

Ironically, we will have succeeded if power controls become *less* noticeable to people than at present. The goal is to make the controls so ubiquitous and consistent that they recede into the fabric of life and don’t call attention to

themselves. This will allow people to better focus on actually using devices and facilitate the energy savings at the root of this effort.

Resources and Call to Action

Resources

All project information is available at: http://eetd.LBL.gov/Controls

Call to Action:

- For everyone:
  E-mail Bruce Nordman at BNordman@LBL.gov and ask to be put on the project e-mail list for periodic updates.
- For system manufacturers:
  Evaluate your current products and new product designs for consistency with these recommendations. Publicize the standard to other parts of your company, notably designers of non-PC devices. Conform future products to the voluntary standards as feasible.
- For device manufacturers:
  Evaluate your current products and new product designs for consistency with these recommendations. Publicize the standard to other parts of your company. Conform future products to the voluntary standards as feasible.
- For industry specifications and requirements:
  Adopt these recommendations and define a schedule for converting some of them to requirements.
- For PC operating systems:
  Implement the changes identified above and any others needed to comply with the standard. Operating systems for servers and for small devices (for example, phones and PDAs) may have special needs.
- For ACPI:
  At the next time that the specification comes up for revision, consider the feasibility of the recommendations above and implement them as possible.

Feedback:

- To provide feedback contact:

Bruce Nordman
510-486-7089
BNordman@LBL.gov
http://eetd.LBL.gov/Controls
Lawrence Berkeley National Laboratory
1 Cyclotron Road, 90-4000
Berkeley, CA 94720 USA

Acronyms and Terms

ACPI – Advanced Configuration and Power Interface

DPMS – Display Power Management Signaling

IEC/ISO – International Electrotechnical Commission / International Organization for Standardization

Interface Element – Part of a user interface such as a symbol/icon, term, or indicator light.

UI – User Interface

VESA – Video Electronics Standards Association